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ABSTRACT

Data were gathered, using pre and posttests and interviews, on the learning of individual students during a seven-week unit on a science topic (conservation) in a fourth grade classroom. Case studies of the learning experiences of each child, based on recordings and detailed observations of all class activities, were used to predict student learning and memory for each content item in the posttests. Analysis of the predictions made by researcher and class teacher revealed the significance of type of class activity, student learning and friendship hierarchies, prior knowledge and experience, and the teacher's ability to diagnose student misunderstanding. A model of effective teaching and the Haberlee Evaluation technique are described. (Author)

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# UNDERSTANDING TEACHING AND LEARNING IN CLASSROOMS: A PREDICTIVE CASE STUDY APPROACH

(Methodology, preliminary results and implications for teachers)

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ABSTRACT

Data was gathered, using pre and posttests and interviews of the learning of individual students during a seven week unit on a science topic in a fourth grade classroom. Case studies of the learning experiences of each child, based on recordings and detailed observations of all class activities, were used to predict student learning and memory for each content item in the posttests. Analysis of the predictions made by researcher and class teacher revealed the significance of type of class activity, student learning and friendship hierarchies, prior knowledge and experience, and the teacher's ability to diagnose student misunderstanding. A model of effective teaching and the Haberlee Evaluation technique are described.

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## 1. METHODOLOGICAL ISSUES

In "Classroom Studies in New Zealand: Whence and Whither ?" presented at the first N.Z.A.R.E. Conference in 1979, Bruce Wilson and Eric Archer concluded by anticipating an increase in the use of case study methodology set inside the teacher's frame of reference and more open and confident dialogue between teacher and researcher. The present paper is an attempt to show that case study methodology can not only be more fruitful than the previous quasi-experimental methodological tradition in this field, but also more rigorous.

The methodology is more fruitful, partly because it does not rely on a hit-and-miss approach of checking out researcher hypotheses about what might be critical learning variables. Rather the method involves identifying those variables and clusters of variables which the data reveals to be critical to sustained pupil learning.

Furthermore the fruitfulness of the approach derives from the comprehensiveness of the data. Perhaps the most significant finding in the field of classroom research over the past decade is that pupil learning time is related to pupil learning outcomes (Rosenshine 1978). This has limited application for teachers. By contrast the same finding in the present study serves as a first step in identifying what teacher and pupils are doing during the learning time and when time per se does not result in pupil learning. In essence the data enables the researcher to grapple with the question of why academic learning time is critical. Accordingly the results have direct implications for teachers.

The claim for rigour is supported by the characteristics of the methodology. By analysing total class time on a topic the researcher not only enters into the teacher and pupil frame of reference but also eliminates the least obvious source of bias - data selection bias.

Also, by establishing a comprehensive data base using multiple data sources (e.g. transcripts and observational records, tests and interviews, pupil and teacher assessments as well as observer assessments) the researcher is able to make both cross-checks and cross-comparisons within the study.

The use of descriptive codes when recording pupil behaviour rather than category codes enabled the researcher to make what constituted off-task behaviour and what constituted on-task behaviour an open question. The subsequent analysis showed which behaviours related to learning outcomes and which did not thereby establishing a new understanding of on-task behaviour and clarifying the confusion between behaviours which are traditionally socially acceptable in a classroom and behaviours which are associated with learning outcomes.

A predictive technique was employed to test the emergent hypotheses but also to identify researcher bias. The researcher, as an instrument of analysis was postulated to be bringing unsubstantiated naive beliefs to the data analysis so by requiring herself to make initial predictions about pupil learning outcomes and matching those predictions against actual learning outcomes the researcher was able to identify and eliminate assumptions unsubstantiated by the data. Where researcher assumptions were supported by pupil outcome data the subsequent analysis and deduction of formal hypotheses will be tested against a further prediction process, modified, and subjected to yet another predictive test.

One final introductory issue is the apparent conflict between our claim that even the preliminary findings have implications for practice, and the case study methodology. Our view is that the traditional statistical notion of generalisability has not been very useful for teachers. The underlying assumptions of such a notion underestimate the uniqueness and the complexity of classroom teaching-learning situations.

Our own findings with respect to pupil and teacher behaviours associated with learning outcomes are strong, verifiable and provide a data base for a coherent theory of classroom teaching and learning. We have developed practical implications which we require the teacher to evaluate with respect to his/her classroom situation. Where the implications suggested seem relevant and helpful we offer them as a guide to practice.

Further we have developed a teacher and pupil evaluation technique (The Haberlee Evaluation Technique) which teachers can utilize to evaluate the impact of our suggestions on pupil learning in their own classrooms. We view our own findings as effectively generalisable to classroom practice in both primary and secondary schools.

## 2. METHOD

### 2.1 Setting

The study took place within a composite class of 26 standard two and three pupils. The teacher was a senior teacher working within a three class open plan unit with access to a withdrawal room. Although the teachers frequently jointly planned their programmes each class programme operated independently with interchange for language/reading groups only.

## 2.2 The Programme Studied

The programme studied was the current integrated topic: Conservation. This topic was organized around three sub-topics of Erosion, Pollution and Endangered Animals. An average of an hour and a quarter per day was spent on the unit over seven school weeks (almost 42 school hours in total). The programme included language, art, creative movement and social studies while primarily focussing on science.

### The Case Study Pupils - Selection

A case study, by definition, examines an individual case. However, the researcher's intention was to gain understanding about the ways in which fairly 'normal' children learn in class. The data itself would reveal whether there were strong similarities in learning patterns or whether each case showed quite different and unique learning patterns. The researcher's intention was in accord with the teacher's criterion that only children he felt would not be unduly disturbed by observer attention should be studied.

The researcher also wanted to observe children in high, average, and low 'ability' groupings as classified by school assessment procedures. Unfortunately the low ability pupil selected left the district the day before the study started.

The final selection comprised Gus, a boy viewed by the teacher as being of high ability, and Diane and Virginia, both viewed by the teacher as being of average ability. Gus and Virginia came from middle class homes with considerable parental interest in school activities. Virginia's father was head of the school committee. Virginia's father and Gus's mother attended a school open day for parents which occurred during the programme. Diane, by contrast, came from a working class home with two parents. Her father was an alchoholic and absent from the home from time to time. Neither of Diane's parents attended the open day and contact with school was generally minimal.

The contrasts between high and average 'ability' and between home backgrounds was felt to be important.

As a senior teacher R.H. had in his class a number of disruptive pupils and children who were considered to have learning disabilities. In this respect the case study children were not representative of the class. Accordingly, data was gathered on the position of the case study pupils within the class social and learning hierachy.

## 2.4 Procedure

A descriptive record was made of the 'taught' curriculum. This record comprised transcripts of all class discussion lessons, teacher instructions and teacher-led group lessons. Pupil involvement with the 'taught' curriculum was monitored by three observers who alternately recorded a total time description of each case study pupil's behaviour. These observations included peer contact, use of resources and involvement with content along with anything else that happened that could have a bearing on pupil learning. Even coughing and verbal communications were recorded.

Codings were used to facilitate recording and not to classify behaviour. Judgements about the behaviour occurring were recorded separately on the back of observation sheets as a source of data about subjective evaluations. Where 'new' behaviours were observed new codes were invented and where several behaviours occurred they were all recorded. For example, within one half-minute segment Gus could be described as attending to the teacher, fiddling with a rubber, acting out a sequence of being a noisy aeroplane, and communicating with a friend twice. The half-minute segment served to synchronize transcript content and pupil behaviour. This recording process was continuous. Wherever possible the content of peer discussion was recorded verbatim.

Observations of the teacher planning meeting served as a basis for a 90 item test of content. The test was administered as a listening test to all the children within the open plan block and to a control group both before the unit began and again immediately after the unit. The children in the open plan block did the test again one year later. Test results were supplemented by in-depth interviews carried out by the teacher before and after the unit, and by the researcher one year later.

The next step involved the co-ordination of all information concerning each half-minute segment on one data sheet. The data sheets were then individually classified as to their relevance to one or more of the 90 test items. (There was over 15,000 units of data across the three pupils observed). Subsequently the 90 item files of the taught curriculum were allocated to three random groups comprising the three Prediction Sets.

There was, of course, considerable range in the size of item files. Item File Erosion 19-15 concerning the river as an agent of erosion comprised 352 intervals for Gus, 310 intervals for Diane, and 289 intervals for Virginia. Item File Endangered Animals 18-x concerning the Bellbird as a native animal of New Zealand was one of four item files which were not covered in the taught curriculum for Prediction Set 1.

The subsequent analysis of item files (within prediction sets) involved identifying each discrete teaching/learning episode within the file, calculating the time spent on the item during teacher-directed lessons, the time spent on independent or group activity, the time spent where content was directly relevant to the knowledge item as worded in the test, the rate of occurrence of different kinds of pupil behaviours, analysing pupil verbalizations, written and art work and examining the logic of content presentation or occurrence.

For example, an analysis of Item File 9 concerning the term 'slip' (the path where stones and earth have tumbled down a mountainside) reveals the following information with respect to Diane who did not already know the term as measured by the pretest:

Figure 1

| | |
|---|---|
| Number of Episodes: | 12 over 8 days |
| Total Class Time: | 14 minutes |
| Activity Time: | 6⅓ minutes |
| Teacher-Directed | 7⅓ minutes |
| Interactions with T (TD): | 2 |
| Interactions with T (IND): | 0 |
| Occasions raised hand: | 2 |
| Verbalizations to Self (TD): | 0 |
| Verbalizations (Chorus): | 2 |
| Peer Interactions (Verbal TD): | 2 |
| Peer Interactions (Verbal IND): | 5 |

During Episode 1 on Day 2 another pupil erroneously supplies the term 'avalanche' and Diane fails to join a class response. She does not appear to give her full attention to the teacher until Episode 4 where he is describing a local example of a slip. The term is clearly defined by the teacher during a demonstration using sand and water in Episode 7.

During Episode 8 Diane calls out 'slip' in a chorus class response. By Episode 16 (she misses out 5 of the teaching episodes that occur while she is absent or in a different reading group) Diane has clearly understood the term in context as evidenced by her written response, 'Rain and Wind' to an activity chart question: 'What do you think was the cause of the hillside slipping down ?'. Her misconception about wind is prevalent throughout her work.

The final step in the procedure required the researcher, given the taught curriculum for the item and the child's pretest response, to predict the child's post test response and the long-term test response. The actual responses to be predicted included an 'I don't know' option. No overall analysis of data patterns was carried out until the predictions had been matched against actual test scores. Thus the predictions served as a test of the researcher assumptions and impressions at this stage of data analysis.

The teacher predicted pupil responses for 15 items. This step was designed to reveal how far the teacher was able to consciously judge the effect of the taught curriculum and, as with the researcher, to identify unsubstantiated teacher assumptions.

## 3. RESULTS

### 3.1 Prediction Success Rate for Prediction Set One

TABLE 1

Percentage of Correct Predictions for Posttest and Long-Term Posttest: Researcher (30 Items) Teacher (15 Items)

| | Gus | Diane | Virginia | TOTAL |
|---|---|---|---|---|
| Posttest: | | | | |
| Researcher | 76.7 | 66.7 | 70.0 | 71.1 |
| Teacher | 80.0 | 80.0 | 80.0 | 80.0 |
| Long-Term: | | | | |
| Researcher | 86.7 | 70.0 | 53.3 | 70.0 |
| Teacher | 86.7 | 66.7 | 73.3 | 75.6 |
| Both Tests: | | | | |
| Researcher | 81.7 | 68.3 | 61.7 | 70.6 |
| Teacher | 83.3 | 73.3 | 76.7 | 77.8 |

Table 1 shows a high success rate for the initial predictions with the teacher predicting accurately more often and more systematically than the researcher. If a correct prediction had only constituted predicting whether the child had learned or not learned the item (i.e. not upholding the 'I don't know' distinction), the overall successful prediction rate would have been even higher: 76.1% for the researcher and 82.2% for the teacher.

Three main types of prediction errors were common to both teacher and researcher: the prediction of learning from the unit which did not occur, failure to predict forgetting, and failure to predict mislearning.

Two important issues arise out of the analysis of prediction errors. Both teacher and researcher had difficulty identifying the point at which mere presentation of content was insufficient to bring about learning or, if it did bring about learning, the factors which inhibited anchoring of that learning. And the second very interesting error type showed that again both researcher and teacher were unaware of the extent to which mislearning was occurring.

A clear example of the kind of mislearning that occurred not only for case study pupils but for the whole class is illustrated by Pollution Item 2:

The amount of air around our world could be described as:

a) infinite
b) finite

(Both terms were explained by the teacher during the administration of the test)

c) nobody knows if it is finite or not
d) I don't know

Although 47.4% of the class selected the correct response (b) by long-term post testing time not one child learned the correct response from the unit. Rather, a third of the children selected (b) in the pretest but selected (a) infinite in the post test. An analysis of the taught curriculum revealed that the content had been dealt with in the context of literature where fictional figures like the Lorax tended to escape from smog filled environments by disappearing through holes in the clouds. More significantly the teacher had discussed the way in which plants give out oxygen into the air and effectively renew the air for human beings. Accordingly the children 'learned' that air (which they translated to oxygen) is an infinite resource. Interview comments and extra-test comments made by the pupils confirm this interpretation.

One further prediction error was the failure to predict learning occurring for Gus and Virginia where there was no taught curriculum file. Gus and Virginia were learning items from outside the school curriculum; e.g. that the Native Action Council was fighting aginst the logging of Okarito State Forest. Obviously accurate prediction of learning extra to the curriculum is impossible. What is a critical factor, however, is that Diane learned no items that were not taught during the unit. By contrast Gus learned two such items and Virginia, three. This finding provides important evidence that Diane was disadvantaged in comparison with Gus and Virginia by her lack of access to content outside of the school curriculum. If this finding were successful as a predictive variable for Prediction Set 2 and Prediction Set 3 for items that were not taught during the school curriculum it would provide important insight into our understanding of how home background continues to discriminate against pupil success at school.

Finally, several prediction errors seemed to be related to whimsical test choices particularly made by Virginia a year later where she would omit responses selected on the pretest and post-test. The question concerning the test as an instrument of measurement has been explored in depth in 'Measuring and Understanding the Way Children Learn in Class', Nuthall and Alton-Lee (1982).

RESULTS

## 3.2 Learning Patterns Common to Case Study Pupils for Prediction Set One

TABLE 2

Breakdown of Class Time spent by Case Study Pupils on items Grouped According to Learning Outcomes (Prediction Set One)

| Learning Outcome Items across Case Studies | No. of Items per Category | Mean No. of Episodes | Mean No. of Days | (Mean number of Minutes Spent per Item) Teacher Directed | Individual/ Group Work | Directly Relevant | Mean for Total Time |
|---|---|---|---|---|---|---|---|
| Learned & Sustained | 11 | 18.3 | 6.8 | 29.3 | 68.2 | 75.0 | 97.4 |
| Already Known | 36 | 9.8 | 5.5 | 19.5 | 23.8 | 32.8 | 43.3 |
| Learned & Forgotten | 8 | 8.4 | 4.0 | 12.5 | 13.3 | 13.8 | 25.8 |
| Not Learned | 18 | 3.8 | 2.4 | 7.1 | 5.0 | 6.3 | 12.1 |
| Mis-Learned | 7 | 4.0 | 2.7 | 6.8 | 0.7 | 0.0 | 7.6 |

Note: Endangered Animals Items 19a (an open ended question) and 20 (an attitudinal item) were not included in the Set One Summary Analysis. Also four items correct on the first two testing occasions but incorrect on the long term posttest (Virginia only) were excluded.

Table 2 shows that, on average, items where more time was spent in both teacher directed lessons and independent or group activity were more likely to be learned and sustained a year later. The average time spent per items learned and sustained under teacher direction, was almost two and a half times as long as that spent for items learned and forgotten. Activity time was five times longer for items learned and sustained as for those forgotten later. Items that were mislearned had, on average, the least teacher directed time and no activity time.

Another important feature of the structuring of time in class with respect to learning outcomes is that repetition and/or the spreading of content over a number of discrete episodes related to learning outcomes. Content learned and sustained had occurred over more than one school week.

The second highest average time spent across items occurred for content the children already knew. In effect, they spent considerable class time reviewing and developing concepts for which they already had some understanding. The implications of this finding are considered to be very important and will be discussed later.

TABLE 3

Rate of Pupil Behaviours Per Hour with respect to Learning Outcomes (Prediction Set One)

| Learning Outcomes | Teacher Directed Activities | | | | | Group & Independent Activities | |
|---|---|---|---|---|---|---|---|
| | Individual Interactions with T. | Hand Raised | Verbalizations Self | Verbalizations Group | Peer Verbal Interactions | Interactions With T. | With Peers |
| Already Known | 8.7 | 13.7 | 11.1 | 3.7 | 19.4 | 3.6 | 47.2 |
| Learned & Sustained | 8.0 | 10.0 | 9.6 | 5.1 | 13.5 | 3.2 | 50.7 |
| Learned & Forgotten | 6.3 | 7.5 | 7.5 | 5.0 | 12.5 | 1.7 | 19.4 |
| Not Learned | 5.5 | 13.5 | 4.0 | 1.0 | 11.0 | 2.7 | 69.1 |
| Mislearned | 7.5 | 10.0 | 2.5 | 2.5 | 2.5 | 0.0 | 0.0 |

Table 3 shows patterns of pupil behaviour with respect to learning outcomes. Again there are very strong patterns showing relationships between active pupil processing of content and learning outcomes across case study data.

Peer interaction is, surprisingly, shown to be associated with sustained learning outcomes when it occurred during teacher lessons. Two main kinds of verbal interactions occurred between peers during teacher lessons. Either the case study pupil would discuss with the person he/she was sitting next to on the mat something the teacher had said, or, if frustrated because the teacher was not responding to a hand up signal, the case study pupil would give his/her answer to a neighbour.

Hand raised frequencies appear either to reflect that pupils are learning and understanding the content or that they are trying to clarify something they do not understand with the teacher.

Case study verbalizations to self (under the breath) were again clearly associated with learning outcomes indicating that important processing was occurring with respect to new content in this way.

The teacher utilized chorus responses from the children frequently by issuing general questions often requiring simply a yes/no answer. For example'Is snow an agent of erosion ?' These question and group response sequences were usually followed by further teacher clarification.

The high rate of 8 public individual interactions with the teacher across case study pupils for items learned and sustained, marks the importance of active pupil involvement with verbal lessons.

The finding that the highest interaction rates occur with respect to content the children already know is particularly important to understanding how the teacher uses the class to teach the class i.e. the teacher appears to be using pupil responses to teach other children. For example, the first time the teacher introduces the concept of environment as new content he elicits the term from the class. This finding is of considerable importance in the light of Greta Morine-Dershimer's conclusion in 'Who hears Whom: Classroom Status Variables and Pupil Attention to the Comments of other Pupils' (1981):

> "One of the most interesting and surprising findings of the main study was that pupils reported hearing the comments, or answers, of other pupils significantly more often that they reported teachers' questions, or any other type of teachers' comments."

Thus the very high rate of public interactions with the teacher about items already known, illustrates the teacher's effective use of peer attention to peer verbalizations. Pupil memory of classroom lessons one year later in the interviews carried out a year after the study also supports Dershimer's findings.

The findings with respect to independent and group activity time also reveal the importance of peer interaction with respect to learning outcomes. Table 3 shows a rate of interaction per hour two and a half times greater for items learned and sustained than items learned and fotgotten. An analysis of the very high interaction rate associated with items not learned revealed that this figure was largely a consequence of a reading group activity both Diane and Virginia were required to do for another teacher preparing a speech about a conservation group. After a flurry of peer questioning for information which was not, of course, forthcoming the children asked permission to go to the library.

Again a very high rate of peer interaction occurred as they sought information from each other in frustration with their inability to find any in the indexes. Finally both children settled to work, working on after the bell writing about the rubbish men picking up litter and forest rangers - obviously from their existing knowledge. More peer interaction unrelated to the topic occurred for this activity time than usual. This could be directly linked to the high frustration level of the teacher's requirement.

A pattern of peer interaction which occurred frequently throughout the unit comprised a sequence of a pupil recording a line or two of written work, reading it back to a friend, listening to the friend's comments (often with great hilarity), rubbing words out and changing the written ideas then proceeding to write again until interrupted by the friend reading his/her ideas. The observers' subjective evaluations of this characteristic behaviour pattern were pejorative. They felt the children were wasting time. Given a conventional coding schedule the observers would have judged such behaviour to be off-task. When the pupil work associated with this characteristic behaviour pattern was later examined it was found to be more accurate, more coherent, and far more polished than work done by case study pupils without critical peer interactions.

FIGURE 2

A Model of Effective Teaching/Learning Steps Deduced from an Analysis of the Taught Curriculum of Items Learned and Sustained

The steps outlined below are sequential but at steps C, D, E, and F, the teacher may repeatedly return to Steps A and B to diagnose misconceptions, reinforce, and extend the taught curriculum.

| Sequence of Steps | Possible Feedback Loops | Description of Teaching/ Learning Step | Percentage of Learned and Sustained Files for which the step occurred |
|---|---|---|---|
| A | | Teacher Relates New Content to Prior Experience of Pupils | 87.5 |
| B | | Diagnosis and Clarification of Prior and Emerging Misconceptions | 75.0 |
| C | A<br>B | Explanation of New Content | 100.0 |
| D | A<br>B | Identification of Instances and Non-instances of the Content being Taught | 100.0 |
| E | A<br>B | Use of New Content in Context (Context of a Demonstration Model) | 100.0<br>75.0 |
| F | A<br>B | Pupil Expression on New Content through Independent or Group Activity (Written, Art, Creative Mime) | 100.0 |
| G | | Extension of Taught Content using Taught Content as Existing Knowledge Structure Base for NEW Content.<br><br>(A new sequence begins) | 87.5 |

In Figure 2 it can be seen that Step A and Step B were integral to the teaching approach throughout the taught curriculum for the learned and sustained item files. Further evidence for the critical importance of Step A, Step B and Step F (pupil expression of new content through individual of group work) was provided by comparing the taught curriculum sequences for items learned and sustained with taught curriculum sequences for items learned and forgotten.

Virginia, for example, spent 73 minutes in total over 23 episodes, five of which involved activity work, learning about introduced animals. Her prior belief, however, that introduced animals are animals that live in bush country was never clarified. She was able to get the item right on a post test but her long-term test response indicated that her initial misconception

The second instance of the importance of Step B (Clarification of misconceptions) illustrates how pupils develop misconceptions in the course of the taught curriculum.

Diane mislearns and suatains her mislearning that the deafening noise of an aeroplane is not a kind of pollution. During Episode 3 of the taught curriculum file (Pollution 19-f) Diane calls out 'aeroplane' when it is her turn to provide a word describing polluted air. The teacher points out that she is wrong, and later makes a kindly reference to her error; apparently assuming that she will realize her error is to do with part of speech rather than the validity of aeroplane noise or smoke as a source of air pollution. Diane, however, 'learns' that aeroplanes are not sources of pollution.

The overall analysis of the taught curriculum for items learned and forgotten revealed that 50.0% of the forgetting seemed to be associated with lack of prior experience and/or failure to clarify misconceptions which later surfaced over the 'learned' content, and the other 50.0% of forgetting could be traced to the absence of any independent or group activity time providing an opportunity to anchor the learning.

Pupil inexperience was a factor which seemed to be plausibly related to two of the case study pupils forgetting that snow was an agent of erosion. During the taught curriculum another pupil asked Gus what snow was. The teacher also used his own experience in an anecedotal account of the noise of an avalanche he experienced at Mt Cook. Accordingly Virginia 'learned' that snow is an agent or erosion because it makes a loud noise in an avalanche. It seems crucial therefore that the teacher relate new content to pupil experience rather than his/her own experience.

With another item about the nature of the eroding process in a mountain stream Diane is seemingly unable to learn because she has never been in the mountains. This is in spite of the teacher using related sensory simulations including movement and art activities in his teaching. Her illustration shows a mountain stream running through flat country with the mountains towering behind. Gus and Virginia by contrast had sloping streams in their pictures. Following a language activity where the teacher elicited words describing a mountain stream from the children and recorded them on a blackboard the children were asked to write their own sentence. Although every word Diane used was on the blackboard, she put them together in a way that described a stream most unlike the one the Teacher and class had been depicting:

Diane: 'The sparking bubby[1] stream tumbled mumbling down the steep rocky mountain'.

Gus 'This rocky rumbling mountain stream erodes the bulky rocks as it swiftly tumbles down the steep hill'.

1. 'sparking bubby' - pupil's errors

The feedback loop system operating between the ongoing revelation of existing pupil structures and misconceptions and subsequent teacher selection and treatment of content seems clearly to be the key to the teacher's successful teaching.

Rosalind Driver (1982) observes in a review of research into science teaching:

> 'All these studies make the assumption that learning in science requires the restructuring of children's conceptualizations. Yet there are few studies which investigate this process in action in classrooms.'
> 'If conceptual learning involves such major restructuring of ideas, then this has implications for instruction: we may need to pay as much attention to the learner's current ideas and how they change as we do to the structure of the knowledge to be taught.'

The interesting feature of Driver's observation is that even though she is concerned about matching instruction to the learner's ideas she refers to the structure of the knowledge to be taught almost as a separate issue. The model depicted in Figure 2 suggests strongly that the teacher was successful in structuring content when he structured it in response to pupil ideas and misconceptions.

The implications of this finding are considerable. The traditional beliefs about structuring knowledge for teaching, particularly in the Secondary School, have not been oriented toward ongoing sensitivity to pupil conceptions. In student teacher training programmes the focus on lesson plan sequences developed and carried out independent of pupils' prior conceptions leads to a model of Teacher as a performer in front of children. The present model by contrast, depicts the interaction between class and teacher as the prerequisite to content structuring.

## 3.3 CASE STUDY PUPIL COMPARISONS

The following results outline the place of the case study pupils within the peer power, learning and friendship hierachy, characteristic case study behaviour patterns and factors which related to individual case study learning outcomes.

TABLE 4

Case Study Pupil's Position in the Class Power and Learning Hierarchy *

| | Number of Peer Votes | | |
|---|---|---|---|
| Selection Criterion | Gus | Diane | Virginia |
| Leader of Whole Class Discussion | 3 | 1 | 4 |
| Leader of Group for Art Activity | 1 | 2 | 3 |
| Leader of Small Group Written Activity | 5 | 2 | 3 |
| Working Partner (General) | 3 | 2 | 3 |
| Friend | 3 | 2 | 2 |
| Total Votescore | 15 | 9 | 15 |

Class Votescores ranged from three scores of zero to three top scores of 15. Gus and Virginia were top equal with one other boy of the class power and learning hierachy. Diane's score of 9 was the third highest score and her position was fifth from the top score, over twice the median score of 4 and one and a half times higher than the mean class votescore of 5.6 votes. Gus, Virginia and Diane were among the six most highly esteemed pupils in the class.

* Note: An interesting observation arising out of the study was that the status and power in the class learning hierachy was related to children's knowledge as perceived by their peers and to ownership of felt pens. Over the unit time frequent peer discussion of cost, brand name, tip thickness and colour quality of felt pens occurred. Further, the ability to borrow, and obligations to lenders appeared to be important factors in position within the class. The importance of both cultural capital and economic capital to the classroom social system was considered to be an important preliminary finding meriting further investigation.

TABLE 5

Rate Per Hour of the Occurrence of Teacher Interactions, Peer Interactions and Hand Raising for the Three Case Study Pupils over the Seven Week Unit (Interaction rates during co-operative group activity were not included as during this time they were generally continuous)

| Pupil | Teacher Directed Time | | | Independent & Group Activity | |
|---|---|---|---|---|---|
| | Interactions with T. | Hand Raised | Peer Interactions | Interactions with T. | Peer Interactions |
| Gus | 8.0 | 11.7 | 37.3 | 3.9 | 61.6 |
| Diane | 4.7 | 7.9 | 10.9 | 4.2 | 34.8 |
| Virginia | 4.8 | 10.4 | 11.8 | 4.4 | 61.5 |

The main differences between case study pupil behaviour are rate of interaction with peers under both conditions and rate of interaction with the teacher during directed lessons. Gus's rate of peer interaction during teacher lessons concords with the optimal learning rate as shown for all three pupils in Table 3. In effect, his normal rate of interaction with T is optimal during this time.

Diane and Virginia both show far more passive interaction rates during teacher lessons of about one every ten minutes whereas Gus is verbally interacting with peers more than once every two minutes. An analysis of non-verbal communication rates showed non-verbal communication to be unrelated to learning outcomes in any systematic way, hence, these rates have not been outlined.

Peer interactions during activity time reflect the class votescore patterns with Gus and Virginia scoring equally high totals with a rate of more than one interaction per minute. A great deal more of Gus's interactions however involved him giving assistance to peers in contrast with Virginia who was more often eliciting assistance from peers.

Observational data supports the quantitative finding concerning Diane's lower interaction rates with peers. She worked alone frequently. Although she sat with other groups of children Diane avoided interactions about content and tended to ask advice over spelling or request a rubber. A comparative analysis of the case study pupils' written work between work done when working alone and when working consultatively with peers clearly indicated the higher quality of the work carried out under the latter conditions.

Peer interaction during activity time is associated with overall interaction rates with the teacher of about four per hour. This high interaction rate with the teacher reflects the teacher's high involvement with his pupils individually. Often these contacts provided diagnostic information for the teacher which he then used to clarify information for the whole class.

Observational data showed Gus and Virginia to be very effective leaders of group activity although Virginia tended to be very partisan to her own interests which frequently gave rise to heated group discussions. Gus's and Virginia's leadership was never challenged.

Diane, by contrast twice lost effective control of her group when ousted by pupils with lower positions in the class hierachy. Although she was very fair and systematic in her attention to all group member viewpoints her control was less assured than that of the other two case study pupils who operated with a more authoritarian approach. Her attempts were more in accord with teacher instructions about democratic practices with recalcitrant group members but were less successful. She was ousted from a leadership position on one occasion when she defended her own incorrect spelling in the face of another pupil's challenge. A request to the teacher to adjudicate not only altered the spelling but also the group structure. Pupil knowledge seemed to have an important relationship to peer acceptance and recognition of leadership.

With respect to Prediction Set One each of the case study pupils learned and sustained four items. However, because Gus and Virginia already knew 56.7% of the items and Diane only knew 40.0% of the items Diane's total score was lower.

The importance of prior experience to case study learning outcomes has already been discussed as has the importance of access to interaction with peers, and opportunities of learning school related content outside of the school curriculum.

Two further issues which differentiated the case study pupils with respect to learning outcomes were access to resource material and learning orientation.

Gus's superior reading ability gave him considerable access to information unavailable to the other pupils as did the speed with which he was able to scan references and glean information. Also, in the top reading/language group he had access to more complex and detailed coverage of content. This effect was equalized to some extent by the teacher putting all material the top reading group used onto a listening post. In a pilot to the present study the content which occurred in a listening post situation, was effectively learned by low 'ability' pupils even when it concerned complex concepts related to the solar system. At the listening post pupils listened to a tape and at the same time followed the oral presentation from the written script.

Pupil learning orientation was found to be a factor which discriminated very sharply between case study pupils. This was particularly so between Gus and Diane. Whereas Gus would not proceed with an activity he did not feel he understood sufficiently, Diane's chief concern seemed to be to get the activity finished. Frequently she was first finished having completed all the presentation requirements cutlined by the teacher but a record of her work showed important gaps in her understanding of material. Gus, by contrast once ripped up an art print he was doing because he was not expressing his concept effectively. Other class members were horrified and spoke in hushed whispers about Gus's outrageous behaviour. One of his friends explained to him that getting as many finished products as possible was far more important that getting his ideas across ! Gus's frequent attempts to clarify his own misconceptions with peers and teacher often resulted in teacher reprimands about his failure to sit down and work. However, he seemed to totally disregard such reprimands and persisted until he obtained the relevant information. On more than one occasion the teacher subsequently used his queries to clarify content to the whole class.

In summary, all the evidence on differences between case study pupil learning patterns leads the researcher to conclude that ability was an entirely inappropriate explanatory factor. When Gus lacked relevant prior experience (which was infrequently) he was every bit as handicapped as Diane with respect to subsequent learning. Rather than ability as a single explanatory factor the research shows a number of factors to be critical. Access to prior experience, access to content through peer and teacher interaction, access to resource content in written form, access to content outside the school curriculum and a learning versus a social conformity orientation were the six factors which served to explain pupil learning outcomes far more plausibly.

## 3.4 ATTITUDES AND THE HIDDEN CURRICULUM

A separate analysis of three items designed to measure changes in pupil attitudes revealed dramatically different results from the results for knowledge outcomes. This analysis is outlined in depth in 'A Process-Product Approach to Understanding the Hidden Curriculum' - Alton-Lee (1982).

The following discussion pertains to an item used to measure the change in pupil attitudes to endangered animals. The teacher spent 12½ hours over 13 school days on this topic. The taught curriculum included class lessons and group and individual activity work, a visit to a local wildlife park, exposure to a number of children's literary classics on the topic such as 'The Lorax' by Dr Seuss and a clear statement by the teacher that the slaughter of elephants is a despicable consequence of man's greed.

The item used to measure attitude change was worded:

"Would it matter if all elephants in the world died out ?

Yes. Why ?

No. Why ?

I have no strong feeling on this."

Children's responses were not classified under the "Yes - it does matter" "No - it doesn't matter" format. Only one child responded "No". This response occurred on the third testing when she wrote, "No, because we have no use for them". The utilitarian viewpoint she indicates is, however, the most prevalent attitude throughout the tests: hence the classification:

Utilitarian - Yes, it would matter because man uses the elephant.

Concern - Yes, it would matter because elephants are nice/have a right to live, and

No Strong Feeling.

Class Results

An examination of results reflecting a positive move in pupil attitudes revealed that two children who had no strong feelings on the matter became concerned after the unit, and one child moved from a utilitarian viewpoint to a concerned one. One year later all three children had deteriorated in their attitudes: two to utilitarian reasoning and the other to a position of no strong feeling. In effect, none of the children developed long-term concern for elephants as a direct consequence of the unit.

The other marked change of attitude came from the five other children who moved from a position of No Strong Feeling to a Utilitarian viewpoint. This move seems extraordinary as it is the most perceptible attitude change and is in direct conflict with the teacher's content i.e. the teacher outlined how the elephant was dying out because of commercial exploitation. The pupils however,are concerned that the elephants will die out because we (man) will not be able to continue to use them.

The children who were initially concerned for the elephant per se hold fast to their attitude through the three tests. One of these argues in both the pretest and the long-term posttest that the elephant has as much right to live as man has. However, after the unit she argues that the elephant has more right to live because it does not erode and pollute its environment as man does ! Two more children hold a position of concern for the elephant per se on the third testing occasion seem to have changed their attitudes outside the classroom situation.

The reasons given by the children who take a Utilitarian stand include:

'Yes. Because they work hard at pulling.'

'Yes. Because there would be no way for India to deliver logs.'

'Yes. Because we would have no ivory things.'

'Yes. Because in Africa they wouldn't be able to use them.'

'Yes. Because if there were no more left we would not be able to go to the zoo.'

'Yes. Because people want to see them.'

'Yes. Because other countries use elephants for work.'

The absurdity of these findings, apparently unexplained by the taught curriculum, led the researcher to compare the data with test results for the two other classes within the open plan block which had studied the same topics over the same period but for which no observational data of the taught curriculum was available. The test had also been administered to a number of children from other classes and to seven children who had moved into the school from other schools.

For one of the other classes only one child had become concerned for the elephant per se but had responded "No Strong Feeling" one year later. In the third class no child had become more concerned in spite of teacher intentions that they should do so.

Out of the 136 children questioned just under half (49.3%) had employed the Utilitarian viewpoint to answer the question. A further 35.3% had no strong feeling on the matter. Only 15.4% of the children expressed concern unrelated to the elephant's use to man.

What was even more surprising, however, were the other children's utilitarian reasons; which included, concern for the loss of the elephant as a source of food and clothing (skins) on several papers.

The interviews held a year later when children were questioned about their responses to the test provided a further source of information about attitude outcomes. At these interviews the pupil had a blank test form in front of her/him and the interviewer held the child's earlier completed test.

The interview, Protocol A, gives Diane's response which was of the most concerned responses from the class. The interview shows that although she is concerned she has reservations:

Interview Protocol A

I. What did you feel about the animals ? If all the elephants died ?

Diane Well..

I. Quite sad, I think, is what you put down there.

Diane Yeah. Yes actually 'cause they can't actually harm us and they're starting to get extinct and, well, they're sort of harmless animals in a way. You know, they can be vicious if they want to, but if they're not vicious they can be quite friendly.

Another interview, Protocol B, is more typical of the other pupil responses. The pupil responded twice that he had no strong feelings and then moved towards a utilitarian position.

Interview Protocol B

I. Do you think it would matter if all the elephants died and there was none left ?

P. Yes, yes, no.

I. Oh, don't you think it would matter ?

P. Oh. Yes.

I. Why do you think ...

P. Oh because if they died out and say the horses died out we'd - they're good use for transport for us and that.

I. Mmn. For no other reason.

P. No, I think they're used for meats as well.

I. Yeah. But you don't ... what if the elephant wasn't good for anything. What if it were just there. Would it matter.

P. No, it wouldn't matter if it died out. No, I suppose it wouldn't.

I. You wouldn't care ?

P. No

I. Mmn. OK.

P. I suppose I wouldn't really think about it.

In summary, not only is there minimal change in the children's attitudes but the change that does occur is, overall, in direct conflict with the taught curriculum.

The children themselves seem to be accommodating the taught curriculum to pre-existing structures for learning. In this case the structures are clearly oriented towards economic and utilitarian reasoning. The curriculum is being transformed into cultural capital by the children.

A full discussion of these results is beyond the scope of the present paper. The findings raise more questions than they answer. However, the findings do challenge Bowles and Gintis' (1976) claim that:

> "The heart of process (of reproducing and legitimating a pre-existing pattern) is to be found not in the content of the educational encounter - or in the process of information transfer - but in the form of the social relations of the educational encounter."

## 4. SUMMARY AND CONCLUSIONS

These results show that by tying an analysis of classroom process to knowledge content we can clearly identify process variables which relate to pupil learning outcomes. Furthermore we can begin to identify where factors outside the taught curriculum relate to pupil learning outcomes.

The amount of relevant time spent on the taught curriculum for specific content during both teacher directed and activity sessions was shown to be important, but not sufficient for learning to occur. The relationship between length of time spent on content, how the teacher and pupils structured that content and pupil involvement with the content pointed to a learning process rather than a learning situation as being critical.

Three critical stages in the process were:

a) The relation of new content to children's prior experience and prior knowledge.

b) The identification and clarification of children's prior or developing misconceptions.

c) The anchoring of 'learned' content.

Pupil behaviours which facilitated this process were: sub-vocalizing, calling out, giving public verbal responses, and interacting verbally with peers during teacher lessons. During activity time high peer interaction rates were perhaps even more critical to learning and anchoring than individual pupil-teacher interactions. The consistent rate of teacher-pupil interactions occurring independent and group activity time were important in bringing about pupil learning.

Comparisons between case study pupils showed ability to be an inadequate explanatory factor for learning outcomes. Six factors were shown to be related to differential pupil learning outcomes: prior experience, access to content through peer and teacher interaction, access to resource content in written form, a learning versus a social conformity orientation and access to content outside of the school curriculum.

The finding regarding the deterioration of pupil attitudes despite the high learning outcomes, at the very least draws our attention to the need for empirical data about pupil attitudinal responses to school programmes and their fit with the values of the wider society.

The next step in the study will involve the further testing of the explanations developed from an analysis of Prediction Set One against the taught curriculum files and pupil outcomes for Prediction Set Two and Prediction Set Three.

The strength of the findings from Prediction Set One suggest that they will be confirmed by the further data analysis. Where confirmation does not occur the findings will be modified accordingly.

The Haberlee Evaluation Technique developed by the researcher and teacher is presented in the following section with a number of other suggestions for teachers. The Haberlee Evaluation Technique is a tool that has been designed not only to give teachers a way of evaluating and improving their own programmes but also as a tool by which they can evaluate the findings and implications reported in this study in their own classrooms.

## 5. IMPLICATIONS FOR TEACHERS

### 5.1 The Haberlee Evaluation Technique

The Haberlee Evaluation Technique has been designed by the teacher and researcher to enable teachers and pupils to evaluate their own programmes effectively. The technique differs from traditional school testing procedures in that the focus is on evaluating the teaching and learning rather than the pupils. Test outcomes are tallied across items by the teacher and pupils. This is in contrast to traditional test marking procedures where the number of correct responses is totalled for each individual pupil. We have endeavoured to develop the technique as a practical procedure for busy teachers. Because pupil participation is an integral part of the process no teacher marking is required out of school hours.

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At the outset of a new topic or unit of work the teacher asks the children to complete a written pretest with respect to desired learning outcomes. The test can be very simple with 10 or even five items - whatever is appropriate given the class level and composition, the nature of the new content, and teacher time available.

When the children have completed their test responses the teacher gathers them in, glances over them quickly to assess prior knowledge and preconceptions, and files them in a drawer.

When the topic has been covered in class the teacher administers the same test. She then hands back to each pupil his/her own pretest.

The pupils and teacher then 'mark' pupil learning. After discussing appropriate responses to the first item the teacher then asks the children to indicate whether they learned Item 1. The ensuing discussion might go something like this:

'O.K. Who learned that .....? Who already knew that. What did we do that enabled so many of you to learn that .....?

'Oh dear, what happened with Item 4? Did we do very much on that in class: Who had difficulty trying to understand .....? Could anybody tell me that the problems were there ? Perhaps we should have done more activity work in that area ?'

The teachers could record a brief summary of outcome patterns for a formal evaluation record.

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The Haberlee Evaluation Technique should serve a number of purposes:

a) To orient the children to learning rather than 'getting it finished' 'making it pretty' or pleasing the teacher.

b) To provide a classroom climate where learning is the responsibility of both teacher and pupils.

c) To provide immediate reinforcement for both teacher and pupils.

d) To provide immediate feedback about the effectiveness of the classroom programme with the children and implications for ongoing class programme.

e) To provide, incidentally, a further opportunity to learn content.

## 5.2 CLASSROOM STRATEGIES: SUGGESTIONS FOR PRACTICE

### Equalizing Pupil Access to Content (5.2.1)

a) Evaluate prior pupil experience. Particularly in districts where low parental mobility is evident field trips may be a pre-requisite to pupil learning from the taught curriculum. Where field trips are impractical use classroom demonstrations. For example in the programme studied the teacher used a model of erosion using a vacuum cleaner, jug of water, grass turf, pile of soil and another pile of sand to illustrate erosion in practice.

b) Use listening posts to offer pupils access to content. Where teacher time is limited use good readers to record content.

c) Promote peer interaction with respect to content. For example, in the present study the teacher very effectively used small group discussion of pupils' writing and art work to dislodge misconceptions through peer pressure. Encourage pupil mobility within the classroom.

d) Orient children to a learning focus. Use the Haberlee Evaluation Technique to this end. Discourage pupils from focussing on form at the expense of content. Discourage children from following teacher directed instruction lessons with prolonged attention to headings. Gus's plan of action always involved attention to headings last of all. The girls, by contrast, would frequently forget the point of the activity by the time they had finished their headings. Try and promote a view that rapid production is only one of a number of important characteristics of good activity work.

e) Provide pupil access to peer learning with respect to test taking strategies. Give out practice tests to groups rather than individuals, or at an older class level, to partners. Require children to discuss and agree on every answer thereby provoking interaction about test strategies.

f) If content relates to current events teach the children how to utilize media resources.

Integrating a Diagnostic Focus into Classroom Methods (5.2.2)

a) Class Discussion Lessons. Check that the emphasis is on the teacher using pupil responses to structure the presentation of content rather than on correct pupil responses i.e. 'guess what the teacher is thinking' games. It seems important that children get clarifications concerning wrong responses as they pay considerable attention to responses of other pupils. When pupils ask a number of questions allow pupils to take over the direction of the discussion for the time it seems to take to clarify their concerns.

b) Photographs. The teacher used open questions about photographs very effectively to elicit and subsequently diagnose misconceptions.

c) Brainstorms. Using a brainstorm method at the outset of a new unit (whereby the students tell the teacher everything they know about the topic and she records their responses immediately on a blackboard) provides the teacher with an explicit map of pupil knowledge, prior experience and misconceptions.

Classroom Methods Particularly Valuable with Respect to Pupil Learning Because of the High Level Diagnostic Value and the Facilitation of Pupil Anchoring of Learning (5.2.3)

a) Group Art Activity. Group art activity provided the teacher with critical information about the children's misconceptions which he then used is subsequent teacher-directed clarification episodes. Further the peer pressure in the group served to dislodge misconceptions more effectively than personal interactions with the teacher. The 100% occurrence of this kind of activity work with respect to items learned and sustained speaks for itself.

b) Creative Movement. By requiring the children to act out the process of ice freezing and expanding, rocks tumbling down a river,and forests being cut down, the teacher was able to watch pupil expression of content, diagnose inappropriate conceptions and provide immediate feedback and opportunity for concept development for a whole class group.

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